# Nutrient Permitting Examples Based on DEQ-12

## Reasonable Potential and Effluent Limits Based on Proposed Numeric Nutrient Standards

Below are examples of the permitting process for establishing MPDES permit effluent limits based on the proposed numeric nutrient standards from version 5.4 of DEQ-12. The process follows the TSD in assessing the need for effluent limits (reasonable potential determination) and the development of those limits.

Because the standards are low, and many streams are already listed as impaired for nutrients, most facilities that discharge nutrients will have effluent limits in the MPDES permit.

The examples are for existing facilities and use Discharge Monitoring Report (DMR) data for the past five years. The receiving water N and P concentrations used are random values selected for example purposes only and are not based on any actual data.

### Example 1: Major Wastewater Treatment Facility (zero dilution)

Maximum reported total N concentration = 14.04 mg/L; Total N numeric standard = 300 µg/L.

Maximum reported total P concentration = 0.38 mg/L; Total P numeric standard = 25 µg/L.

Receiving water 14Q10 = 0

Because the receiving water 14Q10 is zero, reasonable potential (RP) is assessed by simply comparing the maximum effluent values for N and P to their respective WQS. RP to exceed the standards exists.

Likewise, because the 14Q10 is zero, following the TSD, the water quality standard is used as the wasteload allocation (WLA) for developing permit limits. From the WLA, the long term average (LTA) effluent concentration necessary to achieve the WLA, based on the 95% probability distribution of the effluent, is calculated using a multiplier from TSD Table 5-1 as follows:

LTA = WLA x Table 5-1 multiplier

The Table 5-1 multiplier is dependent on the coefficient of variation in the facility effluent data and the 95$^{th}$ percentile. In cases where the Department does not have adequate data to calculate a CV, 0.6 is considered the default CV. The examples below show the difference between a calculated CV of 0.2 and the default CV.

LTA = 300 µg/L x 0.853 = 256 µg/L (CV = 0.2);

LTA = 300 µg/L x 0.644 = 193 µg/L (CV = 0.6)

From the LTA, an Average Monthly Limit (30-day average) is calculated based on a multiplier from Table 5-2 of the TSD.

AML = LTA x Table 5-2 multiplier

When establishing an average monthly limit, the multiplier is selected based on the both the CV of the data set and the number of samples to be collected during the monthly monitoring period. For a facility this size the Department typically requires at least 4 samples per monitoring period for nutrients.

**AML = 256 ug/L x 1.17 = 300 ug/L (n = 4; CV = 0.2);**

**AML = 193 µg/L x 1.55 = 299 µg/L (n = 4; CV = 0.6)**

If fewer than four samples were required during a monitoring period the effluent limits would be slightly higher: 320 µg/L (n=2, CV = 0.2) and 348 µg/L (n = 1).

DEQ-12 states that only 30-day average values will be used for nutrient limits, so the applicable AML above would be the effluent limit in the permit. The limits would be effective July – September only.

## Example 2: Major Wastewater Treatment Facility (approximately 50:1 dilution)

In this example RP is assessed after considering available dilution using a simple mass balance:

**$RWC = Q_dC_d + Q_sC_s / Q_r$**

RWC = Projected maximum receiving water concentration
$Q_d$ = Effluent Flow rate
$C_d$ = Estimated maximum effluent concentration based on CV of the data (from TSD Table 3-2)
$Q_s$ = Receiving stream 14Q10
$C_s$ = Instream background concentration (100 µg/L – N; 5 µg/L – P)
$Q_r$ = 14Q10 + Effluent flow rate

Using total nitrogen as an example: The maximum reported effluent concentration from this facility is 15.9 mg/L. The TSD requires us to establish a "projected" maximum concentration, based on the variability of the effluent (represented by the coefficient of variation, CV) and the number of samples in the data set. The maximum reported concentration is multiplied by a reasonable potential multiplier from Table 3-2 in the TSD (95$^{th}$ percentile). This value is $C_d$ in the formula above.

For nitrogen:

RWC = (1.984 mgd)(21,000 mg/L) + (91.1 mgd)(100 µg/L) / 93.1 mgd = 545 µg/L

| | Maximum Concentration (Reported / Projected $C_d$) (µg/L) | Effluent Flow Rate (mgd) | Receiving Water 14Q10 (mgd) | TSD Projected Maximum Receiving Water Concentration - RWC (µg/L) | Proposed Numeric Standard (µg/L) |
|---|---|---|---|---|---|
| **Total Nitrogen** | 15,900 / 21,000 | 1.984 | 91.1 | **545** | 300 |
| **Total Phosphorus** | 9,600 / 12,500 | | | **270** | 25 |

The RWC exceeds the numeric standard; reasonable potential exists; and effluent limits are necessary.

Next a WLA is established using the mass balance approach and taking into account available dilution.

**$WLA = Q_rC_r – Q_sC_s / Q_d$**

$Q_r$ = 14Q10 + Effluent flow rate
$C_r$ = Water quality standard (proposed numeric standard)
$Q_s$ = 14Q10
$C_s$ = Instream background concentration
$Q_d$ = Effluent flow rate

Continuing to use nitrogen as an example, the values in the table below are used in the above formula to calculate a WLA of 9,486 µg/L. The WLA is the concentration of nitrogen the facility can discharge and comply with the water quality standard.

For nitrogen:
WLA = (91.1 mgd + 1.984 mgd)(300 µg/L) – (91.1 mgd)(100 µg/L) / 1.984 mgd = 9,483 µg/L

| | Proposed Numeric Standard (µg/L) | Effluent Flow Rate (mgd) | Receiving Water 14Q10 (mgd) | Instream Background Concentration (µg/L) | WLA (µg/L) |
|---|---|---|---|---|---|
| **Total Nitrogen** | 300 | 1.984 | 91.1 | 100 | 9,483 |
| **Total Phosphorus** | 25 | | | 5 | 944 |

For developing effluent limits, the WLA is considered the chronic WLA. From this WLA, the long term average (LTA) effluent concentration necessary to achieve the WLA, based on the 95% probability distribution of the effluent, is calculated using a multiplier from TSD Table 5-1 (chronic) as follows:

LTA = WLA x Table 5-1 multiplier

The Table 5-1 multiplier is dependent on the coefficient of variation in the facility effluent data and the 95$^{th}$ percentile. In cases where the Department does not have adequate data to calculate a CV, 0.6 is considered the default CV.

| | WLA (µg/L) | Table 5-1 Multiplier (CV= 0.6) | LTA (µg/L) |
|---|---|---|---|
| **Total Nitrogen** | 9,486 | .644 | 6,109 |
| **Total Phosphorus** | 944 | | 608 |

From the LTA effluent limits are calculated, taking into account the variability of the effluent and the number of samples required, by simply multiplying the LTA by the appropriate average monthly limit multiplier in TSD Table 5-2.

| | LTA (µg/L) | Table 5-2 Multiplier (CV= 0.6; n =4) | AML (µg/L) CV=0.6; n=4 |
|---|---|---|---|
| **Total Nitrogen** | 6,109 | 1.55 | **9,469** |
| **Total Phosphorus** | 608 | | **942** |

These limits (AML) would be effective July – September only.

### Example 3. Major WWTP (approximately 3:1 dilution)

Assuming that RP is established, effluent limits are developed as in the previous examples (using the same assumptions for instream concentrations, CV, number of samples, etc.).

| | Standard (µg/L) | WLA (µg/L | LTA (µg/L) CV = 0.6 | AML (µg/L) CV = 0.6 n = 4 |
|---|---|---|---|---|
| **Total Nitrogen** | 300 | 888 | 572 | **887** |
| **Total Phosphorus** | 25 | 83.8 | 54.0 | **83.7** |

## Effluent Limits Based on Variances

The draft version of DEQ-12 (version 5.3) expresses the variance values as long term averages. Part 2.2 of DEQ-12 proposes expressing permit limits for nitrogen and phosphorus (based on the proposed numeric nutrient standards) as 30-day averages only. Limits based on the variances will also be expressed as 30-day averages.

Using the TSD, effluent limits developed from long term average (LTA) values depend on the coefficient of variation (CV) of the data set (the actual nitrogen or phosphorus results from the facility in question) and the number of samples that will be collected during the monthly reporting period. Unless sufficient daily data is available, the Department uses a default CV of 0.6 to make reasonable potential determinations and to calculate effluent limits. Where the only data available to the Department is summary data reported on Discharge Monitoring Reports (DMRs), the default CV of 0.6 is used. The Department will only use a calculated CV when all of the individual sample results are available. The number of samples collected during a reporting period depends on the facility type and is specified in the monitoring requirements of the MPDES permit.

Because the variances are expressed as LTA and the limits are expressed only as 30-day averages, the calculation of effluent limits, following the TSD, is straight forward. The variance numbers are simply multiplied by the appropriate LTA multiplier (depending on CV and number of samples) for the Average Monthly Limit (AML) at the 95$^{th}$ percentile.

**Total Nitrogen**

| CV | No. Samples | TSD Table 5-2 Multiplier | AML (µg/L) based on 10,000 µg/L LTA | AML (µg/L) based on 15, 000 µg/L LTA |
|---|---|---|---|---|
| 0.1 | 4 | 1.08 | 10,800 | 16,200 |
| | 2 | 1.12 | 11,200 | 16,800 |
| | 1 | 1.17 | 11,700 | 17,550 |
| 0.6 | 4 | 1.55 | 15,500 | 23,250 |
| | 2 | 1.80 | 18,000 | 27,000 |
| | 1 | 2.13 | 21,300 | 31,950 |

**Total Phosphorus**

| CV | No. Samples | TSD Table 5-2 Multiplier | AML (µg/L) based on 1,000 µg/L LTA | AML (µg/L) based on 2,000 µg/L LTA |
|---|---|---|---|---|
| 0.1 | 4 | 1.08 | 1,080 | 2,160 |
| | 2 | 1.12 | 1,120 | 2,240 |
| | 1 | 1.17 | 1,170 | 2,340 |
| 0.6 | 4 | 1.55 | 1,550 | 3,100 |
| | 2 | 1.80 | 1,800 | 3,600 |
| | 1 | 2.13 | 2,130 | 4,260 |

**Variance Based Limits for Lagoons**

Variance limits for existing lagoon systems will be based on performance. An average concentration for both nitrogen and phosphorus will be developed from DMR data submitted over the previous 5 years. This average value will be treated as the long term average for the facility. The average monthly limit will then be calculated from this LTA as described above.